have any moisture which it may contain dried up by his (the sun's) vertical beams; while on the other, or dark side, the ground must be frozen hard to the depth of several feet, the mountains covered with glaciers, and the seas blocked up with icebergs. At the very margin between the two hemispheres there will be a narrow temperate zone, which will of course move round the moon, as the latter turns round its axis and presents its different faces successively to the sun; and the only way in which we can see that life could be supported with comfort at the moon (supposing the atmospherical difficulty surmounted) would be by moving constantly round it, so as to keep always in this temperate zone. A queer Noah's Ark-like sight it would be to see the whole inhabitants of the moon, side by side, in a huge procession extending from pole to pole, and hurrying quickly round it at the rate of ten miles an hour—some riding, some driving, and some travelling in slow railway trains; beasts, wild and tame, galloping by their side, and all the birds of heaven flying along over their heads!" The chapter, too, on Astrology, is of a very diverting character, and above all, Zadkiel's horoscope of the heir-apparent to the British throne.

In the face of such an avowal as the author has made, anything like rigidity of criticism would be out of place: but we cannot help expressing regret that his always pleasing and often beautifully written descriptions should occasionally require the support of a more accurate statement of facts. We have so much respect for his ability, and admiration more especially for the high tone of his principle, as to hope that the book may reach a second edition: but in that case we should hope for the removal of several blemishes which it might seem invidious to point out, but which will be obvious to the scientific reader.

T. W. W.

## *OUR BOOK SHELF*

### *Proceedings of the Berwickshire Naturalists' Club*, Vol. vi. No. 4.

THIS is, we believe, the oldest field-club in existence, and has all along been one of the most efficient and most prosperous so far as numbers and funds are concerned. Its publications, moreover, are already numerous, and contain much valuable material for the natural history, archæology, and antiquities of Berwickshire. There must be already a vast amount of material shut up in the transactions of the now numerous local societies, of the greatest value in reference to the natural history of this country and to students of biology generally, but almost inaccessible except to the members of the various societies. It is a pity that some means could not be devised for bringing the most important contributions to local natural history, in its widest sense, together in some systematised form, so that they could be readily referred to and made available to students at large. Sir Walter Elliot refers to this point in his able address on Provincial Scientific Societies, and it is to be hoped that the Committee appointed by the British Association will give it their consideration. Prefixed to the Proceedings before us is the President's, the Rev. F. R. Simpson's, address, which is wholly occupied with an interesting account of the various meetings of the club during the summer of 1872. For this society is purely a field club, meeting only during the summer months, to explore some of the rich vales of Berwickshire or stretch their limbs over some of the bonny Cheviot fells, gathering rich stores of varied knowledge, and finding a glorious appetite for the substantial dinner which usually winds up the meetings. One of the longest and most interesting papers is by one of the secretaries, Mr. James Hardy, "On Langleyford Vale and the Cheviots," being a sort of survey of the district between Wooler and the base of Cheviot, and containing a wonderful amount of information on the geology, botany, zoology, and especially the prehistoric antiquities of the district. Mr. Hardy also contributes some valuable entomological lists to this part of the Proceedings, and various antiquarian papers; while Mr. Robert Hislop has a list of the rarer Coleoptera occurring chiefly in the parish of Nenthorn. Sir Walter Elliot contributes a list of the diurnal birds of prey hitherto found within the club's limits. There are many other valuable papers including a memoir of the late Dr. William Baird, F.R.S., one of the founders of this old society, appended to which is a list of his many writings. There are two very well executed plates of flint implements and a sculptured stone, and a fine portrait of the Club's late Secretary, Mr. George Tate.

## *LETTERS TO THE EDITOR*

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

### Dr. Bastian's Turnip-Cheese Experiments

IN a former communication* I gave an account of a series of experiments by Dr. Bastian, in which it was established that, "by following his directions, infusions can be prepared which are not deprived by an ebullition of from five to ten minutes of the faculty of undergoing those chemical changes which are characterised by the presence of swarms of Bacteria, and that the development of these organisms can proceed with the greatest activity in hermetically sealed glass vessels, from which almost the whole of the air has been expelled by boiling."

In the first paragraph of that paper I adverted to the importance in every experimental inquiry of defining as completely as possible the method by which any given result can be attained. With this consideration in view, I now propose to give an account of additional experiments, made chiefly for the purpose of elucidating the influence of slight variations of temperature on the result. To guard against the possibility of mistake, it may not be unadvisable to remark that, whereas in the experiments previously reported upon, I took no part, excepting as a witness, I am exclusively answerable for those now to be recorded.

Certain particulars in Dr. Bastian's method have been objected to as possible sources of uncertainty. Thus it has been suggested that when a flask, of which the neck has been drawn out to a capillary orifice, is boiled even for ten minutes over a lamp, it is not certain that the whole of the liquid contained in it is heated to the temperature of boiling; and again, that when the lamp is withdrawn in the act of closing the capillary orifice, germs may enter from without. Although I do not attach much importance to either of these objections, I have modified Dr. Bastian's method, so as to render them inapplicable. The modification, however, applies exclusively to the mode of heating the hermetically sealed flasks. As regards the preparation of the liquid, I have in no respects departed from his instructions.

The liquid is prepared by simmering slices of peeled turnip in a beaker containing about a pint of distilled water. The acid infusion thus obtained, is, if necessary, concentrated by evaporation until it possesses a specific gravity of from 1018 to 1020. It is then filtered and neutralised with sodic carbonate. A little Cheddar cheese is rubbed up with a few drachms of the liquid in a mortar, and the mixture strained through calico. By adding the strained product to the rest of the infusion a turbid liquid is obtained, in every drop of which particles of cheese can be detected by the microscope, although there are scarcely any of a sufficient size to be distinguished by the naked eye.

In the first four sets of experiments retorts were used, in the others flasks. In either case they were charged with the liquid of which the preparation has just been described (their necks having been previously drawn out), boiled over a spirit lamp, and sealed hermetically by directing the flame of the gas blow-pipe on the orifice at the same moment that the lamp was withdrawn. The experiments of the first two sets may be regarded merely as more exact repetitions of the former ones. Their results are confirmatory of those previously obtained. In the others the flasks were subjected to the temperature of ebullition under pressures exceeding that of the atmosphere. Although the excess of temperature in no case exceeded two degrees and a half, it will be seen that it exercised a decided influence on the results.

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* See NATURE, vol. viii. p. 180.

The pressures employed varied from one-tenth of an inch to three inches of mercury. According to * Wüllner's table, founded on those of Régnault and Magnus, an excess of 27 63 mill. over the normal pressure (760 mill.), determines an increase of 1° C. in the temperature of boiling, so that here 0°·924 C. corresponds to one inch of pressure. Similarly we have 0° 88 for the second inch, and 0°·873 for the third inch. In other words 100°·92 C. is the temperature of ebullition at one inch, 101°·81 at two inches, 102°·68 at three inches. In describing the experiments I use the expression "turnip-cheese," liquid to denote the neutral infusion of turnip with cheese of which the preparation has been given above; and in recording the results the words barren and pregnant are employed to express the absence or presence of living Bacteria. In any liquid which has been kept five days at the temperature of fermentation there is no difficulty in determining in which of these two conditions it is, for if Bacteria are present at all they are present in such numbers that every field is crowded with them. Bodies which appear to be dead Bacteria are met with here and there in every specimen. They are as numerous in liquids examined immediately after prolonged boiling as in others. They are probably derived from the cheese.

The retorts or flasks were examined after periods varying from three to six days, during which they were kept in the warm chamber at 32° C. Each was tested by observing that when the point of the blow-pipe flame was directed on the neck of the flask the softened part was first drawn in and then gave way with a loud crack.

With these preliminary observations I proceed to give an account of the experiments.

March 1.—Two retorts were charged with turnip-cheese liquid of which the specific gravity was 1017·2, each retort receiving 25 c.c. One was immersed in boiling water in a saucepan for an hour and then placed in the warm chamber: the other was placed in the chamber at once, *i.e.* immediately after it was boiled and closed hermetically. Both were examined on the 4th. The first was barren, the second pregnant.

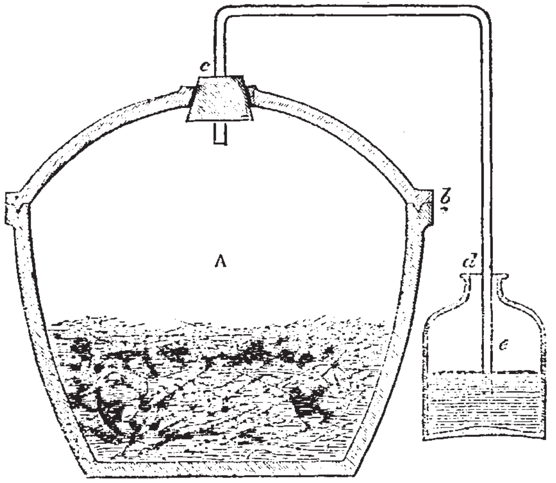
March 4.—Nine retorts were charged with cheese-turnip liquid, sp. gr. 1020. Each contained 35 c.c. After having been boiled and closed hermetically, eight of the retorts were successively subjected in couples to the temperature of boiling water in a digester.

The construction of the digester was such that during the ebullition, which in each case was continued for 15 minutes, steam escaped through various narrow openings. The heating of the retorts was accomplished in four processes, each couple of retorts being heated separately and the valve differently weighted in different cases. Thus in three ebullitions the weights employed were severally 2 lbs., 4 lbs., and 6 lbs., while in the fourth, no weight was added to that of the valve itself. The experiment was planned in this way in order that the influence of pressure might be observed, but in carrying out, it was at once observed that with this view the method was a futile one, for steam escaped so readily in each experiment through the valve that there could be no doubt that all the retorts were in reality subjected to the same temperature, *i.e.* to the ordinary temperature of ebullition. The ninth retort was treated in the same way as the others with this exception, that the ebullition was continued for an hour, the valve remaining open.

The liquids were examined March 10. Of the eight which were immersed in boiling water for 15 minutes, all were pregnant. The ninth retort was barren.

March 13.—Six retorts were charged with turnip-cheese liquid, sp. gr. 1018, after which they were boiled and closed hermetically as before. The retorts were immersed in boiling water as previously, but the experiment was so planned that the pressure under which ebullition took place could be increased at will. The arrangement of the apparatus will be best understood from the diagram. A is a strong iron pot (or digester), the lid of which fits it by a grooved joint *b*. To render the joint air-tight, the groove is filled with white lead before fitting on the lid, which is then tightly wedged into its place. The valve having been removed, the orifice of the digester is stopped by a vulcanite plug, *c*, through which the long tube passes. This forms a perfect joint, for the greater the internal pressure, the more tightly it fits. The end of the tube dips into mercury contained in a large bottle, *e*, and is retained in its place by a holder at *d*, not shown in the diagram. The pot is half filled with water containing a quantity of hay, among which the flasks are arranged. It is supported on a triangle and heated by a Bunsen's burner, the mercury bottle being raised on blocks until the end of the tube dips to about the right depth under the surface of the metal. A more exact adjustment is attained by means of the holder already mentioned.

In this apparatus the six retorts were subjected to the temperature of ebullition under various pressures, viz., two under a pressure of three inches, two under a pressure of four inches, and two under a pressure of two inches. The period of heating in each case was fifteen minutes. All of the flasks were placed, after heating, in the warm chamber at 32° C., and were examined March 18. All were barren.



March 22.—Four retorts were charged with turnip-cheese liquid, sp. gr. 1019, each receiving 50 c.c. Of these two were heated in the apparatus at the temperature of ebullition under a pressure of one inch, the other two under a pressure of half an inch. Of each couple one was accidentally broken. Both the remaining ones were examined March 27, and found to be barren.

May 7.—Nine flasks were charged with turnip-cheese liquid, sp. gr. 1019, each flask containing 50 c.c. Of these, four were subjected to the temperature of water boiling under pressure of one inch of mercury for thirty minutes, and four for the same period to the temperature of ebullition under one-tenth of an inch. They were examined May 12. Of each set one contained Bacteria, the rest being barren. The liquid in the other flask, which was simply boiled, and closed while boiling, had an offensive smell, and contained much scum.

May 22.—Thirteen flasks were charged with turnip-cheese liquid, sp. gr. 1019·5. Of these six were subjected to the temperature of ebullition at three inches, and six to the ordinary temparature of boiling water. The remaining flask, after having been closed hermetically in ebullition in the same way as the rest, was placed with them in the warm chamber. All the flasks were examined May 26. All the six flasks of the first set were barren. Of the six flasks of the second set four were barren, the others contained innumerable living Bacteria. The liquid in the other flask was offensive, and contained masses of bacterial scum.

After the examination several of the flasks containing barren liquids, particularly those which had been heated under pressure, were replaced in the warm chamber. Some of them were simply closed hermetically (the liquid having been taken for examination by means of a freshly drawn out capillary tube), others were closed after the introduction of a drop of distilled water. On opening these flasks several days afterwards, it was found that those which had been impregnated by the addition of the distilled water were full of Bacteria, the others remaining barren. This was done to show that the liquid, although deprived of its power of germination, is as capable as before of supporting the life of Bacteria.

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* Wüllner, Lehrbuch der Experimentalphysik, B. III., p. 559.

The results of the preceding experiments may be summed up as follows:—In sixteen experiments the liquids were subjected to the temperature of boiling at the normal pressure; of these, eight were heated for 15 minutes, and all bred Bacteria; six were heated for 30 minutes, of which two bred Bacteria; two for an hour, both of which were barren.

Of ten subjected to the temperature of ebullition at pressures not exceeding one inch, eight were barren. Both the liquids which were found to be pregnant had been heated for 30 minutes, one under a pressure of one-tenth of an inch, the other of one inch.

In the twelve experiments in which the liquids were heated under pressures exceeding one inch, all were barren, although half of them were subjected to that temperature for only 15 minutes.

It is unnecessary for me to draw any inferences from the preceding experiments; it may not, however, be superfluous to point out that, although all the flasks heated above 101° C. remained sterile, this fact affords no ground for concluding that any definite relation exists between that precise temperature and the destruction of the germinating power of the liquid in question. All that has been shown is that the *chance* that such a liquid will breed Bacteria is diminished either by slightly increasing the temperature to which it is heated, or increasing the duration of the heating. Thus it appears to me quite probable that if a sufficiently large number of flasks were heated even to 102° C., some of them would still be found to be pregnant.

University Coll., London, June 7 J. BURDON SANDERSON

### Fertilisation of the Pansy.—Ground Ivy

THERE is one further point in the structure of *Viola tricolor* which is not mentioned by Mr. Bennett or by Mr. Hart, but which seems to confirm the theory of the former gentleman that *V. tricolor*, as distinguished from most other Violas, is fertilised by a small insect such as Thrips instead of by the proboscis of larger insects.

Before I saw Mr. Bennett's paper, my attention had been called by Miss Dowson to the fact that whereas in the Sweet and Dog Violets, the circle of anthers presses close to the style all round, there is in *V. tricolor* an opening between the two appendaged stamens. The use of this opening will evidently be to allow the small creature to enter in and crawl down the stamen to the nectary at the end of the appendage. This structure may be also seen in *V. cornuta*, which seems to be fertilised in the same way. In *V. tricolor* the opening is exactly opposite to the black streak, or guide-post, as Mr. Bennett has termed it. In *V. cornuta*, although this black mark is not so evident, there is a distinct triangular mark pointing downwards exposed by the opening of the stamens. On each side of the style are two sets of hairs, looking like "whiskers" to the scull-like crest of the style, on which lots of pollen rest. The small insect on entering the flower can hardly help crawling into the cavity at the top of the stigma, for the entrance to the flower is almost completely blocked up by it. On emerging from it it would crawl over the top, which Mr. Hart mentions as seen in *tricolor*, and which I also find in *cornuta*, be guided through the hole by the triangular mark, and so find his way to the nectary. On emerging, covered with pollen, and entering its next flower, it will again be deluded into the *cul-de-sac* in which the stigmatic surface is, where it will deposit its pollen. The details of the structure of the appendaged stamens, as contrasted with those of other Violas, fully bear out this view.

As regards the English translation for the German *bestäuben*, I would suggest to Mr. Hart that "pollenate" is an impossible word; *pollen, pollinis*, must give the verb to "pollinate," as *fulmen, fulminis* gives *fulminate*. But there is a great advantage in a word which speaks for itself, and, if the word "be-pollen" offends scientific ears (Mr. Hart does not tell us why), would the literal translation of the German "to be-dust" be offensive? If not, I think it would tell its own tale. The word "empollen" seems justified by *embalm*, but the prefix generally means to place in or convert into, as in *enthral, emprison, embed*. Hence it would at least be ambiguous.

The form of Ground Ivy mentioned by your correspondent S.S.D. grows here abundantly in several spots, seeds freely, and is remarkable for having a much shorter style in proportion to the tube of the corolla than the common form in which the style and stigmas protrude from the tube. F. E. KITCHENER

Rugby, June 15

Mr. Kitchener having been kind enough to send me the above letter, I may, perhaps, be allowed to add a few additional notes. Since writing the former paper I have had the opportunity of examining three other species of *Viola, V. calcarata, elatior*, and *lactea*, all of which present a remarkable contrast to *V. tricolor* in a very curious point of structure. In *V. tricolor* the stigma is brought into close contact with the lowest petal by a very peculiar "knee" in the style, the effect of which is so completely to close up the central cavity of the flower as to render it extremely difficult for any large insect to insert its proboscis into the spur. In all the three species above-named, which I believe to be fertilised by bees, the style is nearly straight, so as to leave a considerable gap between the stigma and lower petal, quite large enough for the insertion of the proboscis of a bee. In none of these is there the least indication of the black triangular streak on the style which I take to serve, in *V. tricolor*, the purpose of guiding the Thrips to the nectary. The ring of anthers is also perfectly closed, as described by Miss Dowson in the case of the Dog and Sweet Violet, there being no opening for the admission of the small insect, as in the pansy. A striking difference in the form of the stigma also favours the same conclusion as to the mode of fertilisation.

ALFRED W. BENNETT

## *ON THE ORIGIN AND METAMORPHOSES OF INSECTS**

### VI.

THE metamorphoses of insects have always seemed to me one of the greatest difficulties of the Darwinian theory. In most cases, the development of the individual reproduces to a certain extent that of the race; but the motionless, imbecile pupa cannot represent a mature form. No one, so far as I know, has yet attempted to explain, in accordance with Mr. Darwin's views, a life history, such as that of a butterfly, in which the mouth is first mandibulate and then suctorial. A clue to the difficulty may, I think, be found in the distinction between developmental and adaptive changes; to which I have called attention in a previous article. The larvæ of insects are by no means mere stages in the development of the perfect animal. On the contrary, they are subject to the influence of natural selection, and undergo changes which have reference entirely to their own requirements and condition. It is evident, then, that while the embryonic development of an animal in the egg may be an epitome of its specific history, this is by no means the case with species in which the immature forms have a separate and independent existence. If an animal when young pursues one mode of life, and lives on one kind of food, which subsequently, either from its own growth in size and strength, or from any change of season, alters its habits or food, however slightly, it immediately becomes subject to the action of new forces: natural selection affects it in two different and, it may be, very distinct manners, gradually leading to differences which may become so great as to involve an intermediate period of change and quiescence.

There are, however, peculiar difficulties in those cases in which, as among the Lepidoptera, the same species is mandibulate as a larva, and suctorial as an imago. From this point of view *Campodea* and the Collembola (*Podura*, &c.) are peculiarly interesting. There are among insects three principal types of mouth—first, the mandibulate; secondly, the suctorial; and thirdly, that of *Campodea* and the Collembola generally, in which the mandibles and maxillæ are retracted, but, though far from strong, have some freedom of motion, and can be used for biting and chewing soft substances. This type is intermediate between the other two. Assuming that certain representatives of such a type found themselves in circumstances

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* Continued from p. 109.